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Geometrically Nonlinear Problem of Longitudinal and Transverse Bending of a Sandwich Plate with Transversally Soft Core

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Abstract—The stress-strain state of sandwich plates with a transversally soft core is determined in one-dimensional geometrically nonlinear formulation. It is supposed that the edges of carrier layers in the right end section are rigidly clamped and the core is not adhesively bound with the support element. The edges of carrier layers in the left end section are assumed to be hinged on diaphragms that are absolutely rigid in the transverse direction, glued to the end section of the core. A load is applied to the median surface of the first carrier layer from the left end section. On the basis of the generalized Lagrange principle, the general statement is formulated as an operator equation in the Sobolev space. The operator is shown to be pseudo-monotonic and coercive. This makes it possible to prove a theorem that there exists a solution. A two-layer iterative method is proposed for solving the problem. The convergence of the method is examined using the additional properties of the operator (i.e., quasi-potentiality and bounded Lipschitz continuity). The iteration parameter variation limits ensuring the method convergence are found. A software package has been developed to conduct numerical experiments for the problem of longitudinal–transverse bending of a sandwich plate. Tabulation is performed with respect to both longitudinal and transverse loads. The results indicate that in terms of weight sophistication and for the given form of loading, the sandwich plate of an asymmetric structure with unequal thicknesses of carrier layers is the most rational and equally stressed plate.

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INTRODUCTION

The development, implementation, and constant expansion of the use of composite materials facilitate the studies on methods for calculating the structures that are composed of those materials. Recent decades have witnessed an increased production of artificial composites made of high-strength fibers and different polymer matrices. This tendency is projected to grow further. The interest in composite materials is explained by the fact that their structural properties (such as strength and rigidity) are of high level. The design can be facilitated without reducing its loading capacity by using thin-walled elements as shells. These shells are widely used in engineering structures, mechanical engineering [1–3], shipbuilding [4, 5], and aviation industry and rocket engineering [6–8].

This paper considers the one-dimensional geometrically nonlinear problem of the longitudinal–transverse bending of a sandwich plate with a transversally soft core. The stress-strain state in carrier layers is described using the equations of the nonlinear Kirchhoff–Love model. The state in the core is described using the elasticity theory equations simplified in the given model of a transversally soft layer and integrated over the thickness; here, the conjugation conditions for the layers are satisfied with

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